PRODUCTION OF POSITRONS DURING BOMBARDMENT OF THICK FOILS BY FAST ELECTRONS

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ABSTRACT. The angular distribution and outflow of photons and positrons during the bombardment of a layer of substance by fast electrons is investigated. The results obtained closely coincide with the numerical calculations.

This article investigates the angular distribution and outflow of photons and positrons produced during the bombardment of a layer of substance on the order of one radiation unit by fast electrons. These calculations were necessary in order to design converters in those cases when subsequent devices remove positrons in a specific angular interval. It is assumed that the /126*

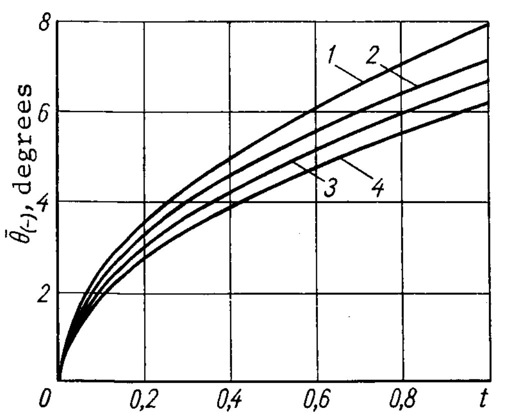

Figure 1. Function $\bar{\theta}_{(-)} = \sqrt{\bar{\theta}^2_{(-)}}$ Determining the Mean Quadratic Angular Deviation of Electrons for the Following Parameter Values E/E_0: 1 - 0.6; 2 - 0.7; 3 - 0.8; 4 - 0.9.

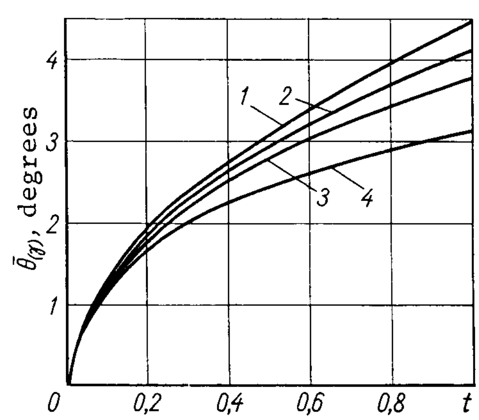

Figure 2. Function $\bar{\theta}_{\gamma} = \sqrt{\bar{\theta}^2_{\gamma}}$ Determining the Mean Quadratic Angular Deviation of Photons for the Following Parameter Values E/E_0: 1 - 0.6; 2 - 0.7; 3 - 0.8; 4 - 0.9.

electrons have energy on the order of several hundreds of megaelectronvolts. For accumulation purposes, positrons having a rather high energy $E \geqq 0.6E_0$ are of interest, where E_0 is the energy of the initial electrons. The process being studied may be described by a system of integral differential equations which take into account the radiation processes and repeated scattering. An exact

* Numbers in the margin indicate pagination in the original foreign text.

solution of these equations by means of the Laplace-Mellin method leads to expressions for the desired distribution functions in the form of contour integrals, which may be computed only on an electronic computer (Ref. 1, 2).

This article develops a method which makes it possible to determine the total number of photons and positrons per unit energy interval and the mean square of the angle for particles having a given energy. The method is based upon the fact that the number of rapid positrons, as well as the number of photons essential for their formation, is small at the depths under consideration $t \lesssim 1$. Therefore, we may employ an approximation of the first kind, with which we may disregard the arrival of electrons due to the formation of pairs, and the formation of quanta with positrons. After these are disregarded, the equations of the cascade theory of showers, written for the distribution functions of electrons, photons, and positrons, may be broken down and may be solved successively. As a result, we have the first two moments P_0 (t,E) and P_1 (t,E) with respect to the angular variable for the distribution function f (t,E,θ): /127

$$P_0 = \int f(t, E, \theta)\, d\Omega; \qquad P_1 = \int \theta^2 f(t, E, \theta)\, d\Omega,$$

and $\theta^2 = P_1/P_0$; dΩ is an element of solid angle.

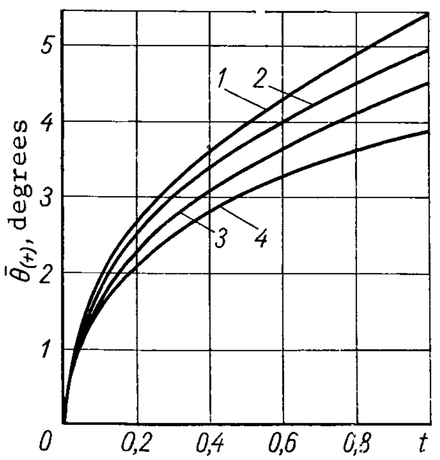

Figure 3. Function $\bar{\theta}_{(+)} = \sqrt{\bar{\theta}^2_{(+)}}$ Determining the Mean Quadratic Angular Deviation of Positrons for the Following Parameter Values E/E_0:
1 - 0.6; 2 - 0.7; 3 - 0.8; 4 - 0.9.

The function $\bar{\theta} = \sqrt{P_1/P_0}$ determines the mean quadratic angular deviation and is shown graphically in figures 1 - 3, respectively, for electrons, photons, and positrons. It is assumed that the initial electron energy equals 200 Mev.

The results obtained closely coincide with the numerical calculation. For small depths ($t \ll 1$), the expressions for the mean squares of the angles of deviation of electrons, photons, and positrons, respectively, assume the following form:

$$\bar{\theta}^2_{(-)} = \frac{E_k^2}{E_0^2}\, t; \qquad \bar{\theta}^2_{(\gamma)} = \frac{E_k^2}{2E_0^2}\, t; \qquad \bar{\theta}^2_{(+)} = \frac{2}{3} \cdot \frac{E_k^2}{E_0^2}\, t,$$

where E_k - 21 Mev; t is the depth in radiation units.

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